

**The Indian Ocean humpback dolphin, *Sousa plumbea* (G.  
Cuvier, 1829).**

**A Status Report for the Arabian Region**

**Robert M. Baldwin<sup>#</sup>  
Tim Collins<sup>#</sup>  
Koen Van Waerebeek<sup>¶</sup>  
Gianna Minton<sup>#</sup>**

<sup>#</sup> Oman Cetacean Research Group, P.O. Box 2531, CPO 111, Oman

<sup>¶</sup> Peruvian Centre for Cetacean Research (CEPEC), Jorge Chavez 302, Pucusana, Lima-20, Peru

Paper submitted to the Scientific Committee of the International Whaling Commission,  
Shimonoseki, Japan, 26 April-10 May 2002

## ABSTRACT

Available data on the genus *Sousa* are reviewed for the Arabian region. Nominal usage of *Sousa plumbea* (G. Cuvier 1828) is retained as a pragmatic measure, based on geographic and morphologic affiliation. Distribution is described for the region to include much of the Arabian (Persian) Gulf, Arabian Sea, Gulf of Aden and Red Sea, but notably excludes the Gulf of Oman. This discontinuous distribution suggests the possible presence of discreet populations within the region.

Most available information on *Sousa plumbea* in the region originates from the Sultanate of Oman, where this species is among the most commonly recorded cetacean. However, there is no absolute measure of abundance here or elsewhere in the region and the status of the species is unknown. Beach cast individuals represent nearly two-thirds of all records (n=269) of this species in Oman. Live sightings indicate unusually large group sizes (up to 100 individuals) in the Arabian Sea and Arabian Gulf. Occasional association with *Tursiops* sp. and *Delphinus* sp. is documented. Mating behaviour and the presence of calves are recorded in the months of April and May and calves are additionally reported in October and December. Little is known about the ecology of this species in the region.

Threats to Indian Ocean humpback dolphins in the Arabian region include incidental capture in fishing nets, general coastal and offshore development (e.g. land reclamation, dredging, port and harbour construction), pollution, boat traffic, oil and gas exploration (including seismic surveying), military exercises and toxins associated with red tide events. Evidence for historic and current directed catches of *Sousa plumbea* is presented.

Intraspecific variation in cranial measurements is presented for cranially adult skulls originating from the Arabian Sea coast of Oman and initial comparison with limited data from the Saudi Arabian Gulf coast are drawn. Cranial abnormalities in skull specimens from Oman are discussed. Curated specimens from the Arabian region are listed.

## KEY WORDS

*Sousa*, Arabian Gulf, Arabian Sea, Gulf of Aden, Red Sea, distribution, biology

## INTRODUCTION

Available data on small cetaceans, including *Sousa plumbea*, in the Arabian region were most recently reviewed by Baldwin *et al.* (1999). Previously, Leatherwood (1986) and de Silva (1987) undertook general reviews of cetaceans in the wider Indian Ocean. Information on Indian Ocean humpback dolphins in the region was also collated in a single volume through the UNEP Secretariat for the Global Action for the Conservation, Management and Utilisation of Marine Mammals (Beardon, 1991; Chantrapornsy *et al.*, 1991; Gallagher, 1991; Leatherwood *et al.*, 1991; Papastavrou and Salm, 1991; Small and Small, 1991). Other published material containing accounts of Indian Ocean humpback dolphins are scattered and present data for more specific areas of the Arabian region.

The taxonomy of the genus *Sousa* remains unresolved and every possible configuration and number in species definition has been suggested in the past few decades, from a single highly variable species *S. chinensis* to recognition of all five nominal species (see discussion by Rice, 1998). As a pragmatic measure, we suggest temporarily retaining nominal usage of *Sousa plumbea* (G. Cuvier 1828), recognized by Hershkovitz (1966) and followed by Rice (1998), for animals that inhabit waters from the western Bay of Bengal and the Arabian Sea until morphologic and molecular genetic studies firmly establish taxonomic relationships and nomenclature. *S. plumbea*, fairly translated in English as “plumbeous dolphin”, aptly describes the widely recognized colouration distinction from the lightly coloured Pacific humpback dolphin or Chinese white dolphin *Sousa chinensis* (Osbeck, 1765). The plumbeous dolphin also exhibits a highly conspicuous dorsal hump that is absent in *S. chinensis* (see Jefferson and Karczmarski, 2001). In the event that *S. plumbea* proves to have subspecific status, usage of *S. chinensis plumbea* will be readily adopted.

*S. plumbea* was first identified in the Arabian region from a skull collected in March 1948 from Karaman Island, Red Sea by D. Thompson. The specimen is curated at the British Museum (BM 1948.3.13.1) (Leatherwood, 1986). Subsequent records come from both the western (Al Robbae 1970; 1974) and the

eastern (Pilleri and Gühr, 1974) Arabian Gulf. Evidence that additional early work was in progress in the region is provided by Gallagher (1991) who documented collections of *S. plumbea* from Bahrain, United Arab Emirates (UAE) and Oman that date back to the 1970's.

Many more recent data on Indian Ocean humpback dolphins of the region come from incidental observations recorded during more general surveys of marine and coastal habitats, particularly along the coast of Oman (Papastavrou and Salm, 1991; Weidleplan, 1992; Salm *et al.*, 1993), as well in Somalia (e.g. Schleyer and Baldwin, 1999).

Surveys conducted specifically to observe and record cetaceans in the region began in 1973 (Pilleri, 1973). Several surveys were conducted in the region during the early 1980's (Harwood, 1981; Keller *et al.*, 1982; Robineau and Rose, 1984; Alling *et al.*, 1986). These included a survey of Indian Ocean humpback dolphins, in the UAE in 1984 (UAECD). A survey conducted for dugongs (*Dugong dugon*) in the Arabian Gulf and Red Sea in 1989, included documentation of sightings of Indian Ocean humpback dolphins (Preen, 1989). Results of this survey prompted an investigation of extensive marine mammal mortality in the Arabian Gulf (ROPME, 1986). More recent survey work in the Arabian Gulf has focussed specifically on small cetaceans, including *Sousa plumbea* (Robineau and Fiquet, 1992, 1994b, 1996; Baldwin, 1995; 1996).

Research in Oman since 2000 has included systematic small boat surveys in near and offshore waters, as well as surveys for beach cast cetaceans, which have resulted in further recording of *Sousa plumbea* (OMCD).

Several general texts on the natural history of the Arabian region refer to *Sousa* (e.g. Basson *et al.*, 1977; Sheppard *et al.*, 1992) and many texts on general and specific aspects of small cetaceans make reference to *Sousa* in Arabia (e.g. Leatherwood and Reeves, 1983; Ross *et al.*, 1994). Additional general texts specifically treat cetaceans of the region and include accounts of *Sousa* (Frazier *et al.*, 1987; Preen, 1987; Baldwin and Salm, 1994; Baldwin, 1995).

## **MATERIALS AND METHODS**

The data reviewed here come from the literature, from records of the Oman Cetacean Database (OMCD), the Oman Natural History Museum (ONHM), the United Arab Emirates Cetacean Database (UAECD) held by the Emirates Natural History Group, Abu Dhabi. The OMCD and UAECD include records from a variety of sources, including data collected during systematic cetacean surveys, data from personal observations of the authors, data from specimens curated at the ONHM and in private collections in the UAE, and from data submitted by other recorders either as incidental records or as a result of dedicated cetacean surveys. The records referred to in the present account are of confirmed sightings/beach cast animals only. Unconfirmed records have been discounted and are not discussed.

For the purposes of this report, we have defined the Arabian region as coastal and offshore waters of peninsula Arabia, including waters of the Arabian Gulf, Gulf of Oman, western Arabian Sea, Gulf of Aden and Red Sea. Data from elsewhere, such as along the African coast of the Red Sea, are included in cases where these are considered relevant or appropriate.

Both currently and historically, research and observation of cetaceans in the region has focussed on particular areas, with most available information on *Sousa plumbea* coming from waters off the Sultanate of Oman and the southern shores of the Arabian Gulf, particularly the UAE and Saudi Arabia. Population estimates have not been attempted in the region for *Sousa plumbea*, or any other cetacean species, to our knowledge, making assessment of abundance and status difficult or impossible. There are also very few data on which to base assessment of stock identity, incidental takes and other threats, life history or disease and parasitic infestation. In general, evidence for the deliberate capture of Indian Ocean humpback dolphins is scant and we believe that this practice is probably restricted in the region to occasional opportunistic hunting. The ecology of Indian Ocean humpback dolphins is also poorly known for the region, and although the following account does not attempt to draw parallels with information collected on conspecifics elsewhere in the world, it is acknowledged that many data may be applicable.

In order to describe intraspecific cranial variation, thirty-eight cranial measurements and tooth counts (Appendix 1) slightly modified from Perrin (1975), were taken for 28 skulls collected from the coasts of Oman as indicated in Table 1. The sample was not gender-stratified considering skulls were derived exclusively from beach-cast specimens. Cranial maturity was determined from the degree of fusion in seven indicative cranial suture lines (Van Waerebeek, 1993), while taking into account possible secondary suture de-fusing in highly weathered specimens.

**Table 1. Indian Ocean humpback dolphin skulls from Oman utilised for descriptive craniometrics**

Adults	Subadults
Khaluf (ONHM 2864, 2865, 2866, 2889, 2958, 2975, 2983, 2959, 2986, 2987, 2988, 2990, 3040, 3041)	Khaluf (ONHM 2867, 2868, 2869, 2985, 2989, 2980)
Ra's Ru'ways (ONHM 2631, 2633)	Ra's Ru'ways (ONHM 2632, 3051)
An Nuqdah (ONHM 2635)	Dhofar, W. of Mughsayl (ONHM 3054, 3058)
Hallaniyah Islands (ONHM 2916)	

#### Abbreviations used

OMCD	Oman Cetacean Database
UAECD	United Arab Emirates Cetacean Database
UAE	United Arab Emirates
ONHM	Oman Natural History Museum, Muscat
BM	British Museum (Natural History), now known as the Natural History Museum, London
ZMA	Zoological Museum Amsterdam

#### DISTRIBUTION

The range of *Sousa plumbea* in the Arabian region includes much of the Arabian Gulf, Arabian Sea, Gulf of Aden and Red Sea (Figure 1). In the Arabian Gulf, records confirm its presence in Iraqi waters (Al Robbae, 1970, 1974), coastal and offshore waters of Bahrain (e.g. Gallagher, 1991) Saudi Arabia (e.g. Robineau and Fiquet, 1996), Kuwait (de Silva, 1987), Qatar (Leatherwood, 1985) UAE (e.g. Preen, 1989; Baldwin, 1995) in the Musandam region of Oman (Pilleri and Gühr, 1974; Baldwin and Salm, 1994; OMCD) and off Iran (Pilleri and Gühr, 1974).

This species' distribution (Figures 2, 3) extends only into coastal waters of the northern extreme of the Gulf of Oman as far south as 26°07'N, 56°23'E in Musandam, and then apparently does not occur between this point and Ra's Al Hadd (22°30'N 59°49'E), which marks the boundary between the Gulf of Oman and the Arabian Sea (Salm *et al.*, 1993; Baldwin and Salm, 1994). The range of *Sousa plumbea* appears to be continuous along the Arabian Sea coast of Oman (Baldwin and Salm, 1994) including some offshore islands, such as Masirah and a single record from the island of Al Hallaniyah (OMCD).

Evidence that the distribution of *Sousa plumbea* continues south into Yemen is provided by records from Gulf of Aden shores (e.g. Leatherwood, 1986). *Sousa plumbea* also occurs along the African coast of the Gulf of Aden near Djibouti (Mörzer-Bruyns, 1960; Alling *et al.*, 1982; Small and Small, 1991) and along the coast of Somalia (Small and Small, 1991; Schleyer and Baldwin, 1999). In the Red Sea the Indian Ocean humpback dolphin is documented along the Arabian coast by de Silva (1987) and Leatherwood (1986) and other evidence (Beadon, 1991) indicates its occurrence in the Gulf of Suez.

#### STOCK IDENTITY

It is unclear whether the apparent discontinuous distribution of *Sousa plumbea* between populations in the Arabian Gulf and extreme north of the Gulf of Oman and populations in the Arabian Sea results from the influence of recent human population expansion and associated development or has an ecological basis. The possibility remains that Indian Ocean humpback dolphins in different areas, for example in the Arabian Gulf, Gulf of Oman, Arabian Sea and Red Sea, represent discrete populations. Salm *et al.* (1993) suggest two discrete populations in Arabian waters, one in the Arabian Gulf and extreme north of the Gulf of Oman and one in the western Arabian Sea.

Samples from *Sousa plumbea* in Oman collected for genetic analysis currently number 40. All of these are from beach cast specimens collected along the Arabian Sea coast.

## MORPHOLOGY

In the Arabian region, and northern Indian Ocean generally, Indian Ocean humpback dolphins are uniformly plumbeous or brownish-grey and we therefore assign them to *S. plumbea* (G. Cuvier, 1829). Some individuals from the Musandam region of Oman present dark bluish-black longitudinal flecks on the body, and may be referred to the *lentiginosa* (Gray, 1866) form, the holotype of which is from Vishakhapatnam, India. This form is most probably synonymous, at species level, with *S. plumbea* (Pilleri and Gahr, 1974; Ross, 1984; Ross *et al.*, 1994). Osteologically speaking *S. lentiginosa* does not differ from the *plumbea* form (Pilleri and Gahr, 1974).

Robineau and Fiquet (1996) provide descriptions of *Sousa plumbea* from the Arabian Gulf coast of Saudi Arabia. Photographs of Indian Ocean humpback dolphins from the Gulf of Oman and the Arabian Gulf appear in Baldwin and Salm (1994) and Baldwin (1995) respectively.

There is some published information on external morphometrics (n=4), craniometrics (n=3) and colouration for *S. plumbea* from the eastern Arabian Sea and the Gulf of Aden (Robineau and Rose, 1984) and limited study on this genus in Oman (Baldwin and Salm, 1994; OMCD). As in populations described from South Africa (Ross *et al.*, 1994), the dorsal fin in northern Indian Ocean animals is elongated and thickened basally (the ‘hump’) at all ages, becoming shorter and thinner mid-dorsally thus forming a small fin-like falcate structure. Pilleri and Gahr (1974) provided photographic information for cranial and postcranial material of *S. plumbea* from Rehri Creek, Pakistan.

The main difference between the vertebral formula of *S. chinensis* and that of *S. plumbea* is observed in the number and relative length of the thoracic (Th) vertebrae (12 Th, 26% of the vertebral length in *S. chinensis*; 11 Th, 22-24% of the vertebral length in *S. plumbea*). The thoracic region is, therefore, relatively longer in *S. chinensis* than in *S. plumbea*. There may also exist some differences in configuration of the scapula (Pilleri and Gahr, 1974). However, material to support these claims is very limited, and effort should be directed to acquire adequate sample sizes of osteological specimens from different regions to allow for appropriate statistical analysis. The few organ and soft-tissue descriptions available for *Sousa* spp. are from specimens collected outside the Arabian peninsula region (see Jefferson and Karzmarzski, 2001).

Intraspecific variation in cranial measurements, both in absolute measurement (mm) and as a percentage of condylobasal length, are presented for cranially adult (n=18) and subadult (n=10) *S. plumbea* skulls originating from the Arabian Sea coast of Oman between Ra’s Al Hadd and south to Dhofar (Appendices II and III). The five cranial measurements for 13 specimens of Indian Ocean humpback dolphins from the Arabian Gulf given by Robineau and Fiquet (1996) fell within the relative values (% CBL) found in our Arabian Sea specimens. Minima in absolute measurements were lower for the Arabian Gulf but 9 of the 13 specimens in the Robineau and Fiquet (1996) sample ‘had not reached physical maturity’, and therefore the samples are not directly comparable. Mean tooth counts in lower left (34.4) and upper left (35.8) half-jaws in the Arabian Gulf seemed slightly higher than these from Omani coasts (respectively 32.7 and 34.7, see Appendix II). However, statistical analysis has yet to be applied to the raw data.

## ABUNDANCE

Records of *Sousa plumbea* from Oman (OMCD) currently number 269, making it one of the most commonly recorded species of cetacean in the Sultanate after *Tursiops* spp. (342) and *Delphinus capensis tropicalis* (274). Of the *Sousa plumbea* records, 172 (64%) are of dead individuals, the highest record in OMCD. A high proportion of live sightings of Indian Ocean humpback dolphins in Oman are made from shore, as boat-based surveys produce a low encounter rate due to the relative lack of nearshore survey effort. In the United Arab Emirates, records of *Sousa plumbea* number 83 (UAECD), including only 4 (5%) dead individuals. This difference in relative numbers of dead and live individuals in Oman and the UAE requires further investigation.

The majority of live sightings of Indian Ocean humpback dolphins in Oman (85 of n=96) are of groups ranging in size from 1 to 20 although some large groups of up to 100 individuals are documented (see below). Average group size is 11 (S.D=14.4, n=96). Similar figures are revealed for the smaller data sets available for the UAE (UAECD) and Somalia (Schelyer and Baldwin, 1999).

Records of *Sousa plumbea* in the western Arabian Gulf include 12 skulls collected from Bahrain between February 1969 and April 1974 by M. D. Gallagher (1991) and 50 sightings of groups of 1-15 individuals near Jubail between December 1991 and April 1993 (Robineau and Fiquet, 1996). Preen (1989) reports 25 positive sightings of Indian Ocean humpback dolphins in groups of 1-17 individuals during aerial surveys for dugongs (*Dugong dugon*) in the Arabian Gulf between 1985 and 1987. The majority of these sightings were in nearshore waters of Saudi Arabia, Bahrain and Qatar, despite the surveys also covering most of the coast of the UAE.

Additional quantitative records of this species in the region are documented by Pilleri and Gühr (1974) who recorded a total of 18 individuals off the southern Iranian coast in the Gulf of Oman.

There appear to be no published data on the abundance of *Sousa plumbea* in the Red Sea, although Frazier *et al.* (1987, p306) suggest that it is 'present in small numbers throughout the Red Sea and Gulf of Suez'.

Although the above data indicate that Indian Ocean humpback dolphins generally occur in small groups, much larger groups also occur in the Arabian region, particularly along the Arabian Sea coast of Oman. Indian Ocean humpback dolphins appear to be particularly abundant here (see Figures 2, 3), and groups of 30 individuals or more have been sighted on 10 occasions, including records of three groups of over 50 individuals, one of which was a group of approximately 100 individuals (OMCD). The latter may have been an aggregation of several groups, possibly involved in breeding (R. Salm, *in litt.* to R. Baldwin, 19 March 1998). A large group (35 individuals) is also documented for the Musandam region of northern Oman.

Relatively large groups of Indian Ocean humpback dolphins, comprising 30 or more individuals, have also been encountered in offshore waters of Abu Dhabi, UAE (Baldwin, 1995; UAECD).

## **STATUS**

Unknown.

## **INCIDENTAL TAKES**

Gallagher (1991) suggests that Indian Ocean humpback dolphins and other cetacean species may suffer incidental capture and drowning in fishing nets in Oman. Five butchered individuals discovered on beaches in Oman (Papastavrou and Salm, 1991; OMCD) may have been incidentally captured in fishing nets, or may have been intentionally caught. The OMCD lists four dead individuals that were found to have been entangled in fishing nets, including one with a broken rostrum. An additional eight individuals are listed that show scarring/rostrum damage that may have resulted from net entanglement. There are several other records of dead animals on beaches in the vicinity of fishing boat landing sites and/or villages. It is likely, given the abundance of set and lost or discarded fishing nets in shallow coastal waters of Oman (Salm, 1992) that this coastal species suffers more mortality as a result of entanglement and drowning than records suggest. Additional analysis and discussion of beach cast cetaceans including *Sousa plumbea* is presented in SC/5404.

A single Indian Ocean humpback dolphin was caught in a purse seine net in the Gulf of Suez, Red Sea, in January 1981 and released (Beadon, 1991).

## **DIRECTED CATCHES**

Indian Ocean humpback dolphins were reportedly hunted in former years in the Arabian Gulf and Red Sea (Ross *et al.*, 1994). Leatherwood and Reeves (1983) suggest that hunting additionally took place in the Arabian Sea. However, neither publication points to evidence upon which these statements are based. Alling (1983) mentions a limited dolphin fishery off Masirah Island in the Arabian Sea, without mentioning species. Gallagher (1991), Papastavrou and Salm (1991) and Baldwin and Salm (1994) all suggest a limited

directed catch of cetaceans in Oman, based on observations of butchered animals (including Indian Ocean humpback dolphins) and interviews with fishermen from Masirah Island and the Halaaniyat Islands. There is some anecdotal and photographic evidence for the continued hunting of dolphins in Oman using small, motorised boats and hand held harpoons. The effect of such practices on this species' status is unknown.

An individual caught by fishermen in Kuwait is reported by de Silva (1987). Whether this animal was deliberately or incidentally caught is not stated.

### OTHER THREATS

Predisposed to a coastal habitat (Ross *et al.*, 1994), *Sousa plumbea* suffers from coastal and offshore development in the Arabian region leading to habitat loss and degradation. This may be particularly severe in the Arabian Gulf (Baldwin, 1995), but also threatens parts of the Arabian Sea coast of Oman, for example due to port and harbour development. Pollution and boat traffic, particularly in the Arabian Gulf (Baldwin, 1995) also threaten this species. Disturbance to small cetaceans from offshore oil and gas exploration, for example seismic surveys, is also documented (Baldwin, 1997). Military exercises are another possible source of disturbance (OWDRG, 2002a).

Gallagher (1991) suggests that poisoning caused by toxins originating from phytoplankton associated with 'red tides' may have caused the death of eight Indian Ocean humpback dolphins found near Duqm (approximately 19°40'N, 57°42'E) on the Arabian Sea coast of Oman in April 1990. Current investigations into chronic and acute mass mortality of sea turtles, fishes and other taxa along the coast of Oman since at least October 2001 (OWDRG, 2002b) suggest that toxic phytoplankton may be a causal factor. At least 13 Indian Ocean humpback dolphins, among other cetaceans, are reported to have died during this period (OMCD).

### ECOLOGY

Indian Ocean humpback dolphins have been observed feeding in shallow waters in the Arabian Gulf, individuals herding fishes of unknown identity onto exposed sand banks and apparently deliberately beaching in order to seize their prey (Baldwin, 1995). Fish otoliths collected from the stomach of an adult individual found on Merawah Island (24°28'N 53°23'E), Abu Dhabi and now at the Centre for Dolphin Studies, Port Elizabeth, South Africa, have yet to be identified (Baldwin and Cockcroft, unpublished information). Salm (*pers. comm.*, 1991) suggests that Indian Ocean humpback dolphins in Oman may feed on sciaenid fishes. A total of eight stomach samples have been collected from dead individuals on the Arabian Sea shore of Oman and await analysis (OMCD).

The known distribution of *Sousa plumbea* in the Arabian region, can be largely correlated with soft-sediment, shallow-water habitat with a low-energy sandy shoreline. However, in parts of Oman its range includes rocky substrate with a higher-energy, rocky shoreline. In some of these areas, there are several sightings of Indian Ocean humpback dolphins over deeper water (>40m). Local differences in the ecology of *Sousa plumbea* may result.

Throughout most of its worldwide range, *Sousa* spp. generally occur in small groups of up to 25 individuals (Ross *et al.*, 1994). The large groups of Indian Ocean humpback dolphins seen in the Arabian Gulf and Arabian Sea may indicate differences in social behaviour between populations here and those elsewhere in the world.

### ASSOCIATION WITH OTHER SPECIES

*Sousa plumbea* has been observed in association with both *Tursiops* sp. and *Delphinus capensis tropicalis* in Arabia, but only very rarely. The latter involved a single individual swimming with a group of *Delphinus capensis tropicalis* close to shore in Musandam, Oman. Interaction with *Tursiops* sp. includes record of aggressive behaviour shown by a group of *Tursiops* sp. towards a single *Sousa plumbea* and on a separate occasion, in the same location, a group of *Tursiops* sp. closely following a group of *Sousa plumbea* (OMCD). Schleyer and Baldwin (1999) observed *Sousa plumbea* off the Gulf of Aden shoreline of northern Somaliland on three occasions, two of which were in mixed schools with *Tursiops* sp. A single *Sousa plumbea* amongst a group of *Tursiops* sp. exhibited behaviour more closely resembling that of the latter species than its own (Baldwin, *pers. obs.*).

### **LIFE HISTORY**

Observations of mating and adults with calves in the months of April and May are listed in the UAECD. The OMCD lists two sightings of calves during the same 2 months, as well as a single sighting of up to ten calves in group of over 50 individuals in October and two sightings of calves in December. There is also a report of a dead individual found on 25 March 1991 at 20°44'N, 58°47'E that measured 1.1 metres in length, the teeth of which had not yet erupted (OMCD). Perrin and Reilly (1984) who reviewed reproductive parameters in delphinids cited 97cm (n=9) as the smallest known individual of *Sousa chinensis* (all regions), lacking an estimate for neonate length. No data are available for other *Sousa* spp.

### **DISEASE AND PARASITES**

No published information is available for the Indian Ocean humpback dolphin on diseases or parasites. None of the 28 skulls from Oman that were examined showed characteristic (basket-like) bone lesions of the ventral cranium commonly associated with *Crassicauda* spp. nematode infestations (e.g. Raga *et al.*, 1982). The proximal ends of both upper tooth rows of adult skull ONHM2864 exhibited, symmetrically, an unusual vacuolar-like depression with smooth contours from unknown origin. The right exoccipitale of ONHM 2631 showed evidence of a healing fracture and significant exostosis was present on the right condylus occipitalis of adult ONHM 2987.



## CURATED SPECIMENS

Museum	Accession Number	Country of Origin
BM	1970.1505, 1970.1506, 1970.1507, 1970.1508, 1970.1509, 1970.1510, 1973.1748, 1984.1758, 1984.1759, 1984.1761, 1984.1762, 1984.1763, 1984.1768	Bahrain
BM	1955.2.23.1	Gulf of Aden
BM	1924{or 1929}.9.11.1	Suez Canal
BM	1948.3.13.1, 1962.2.19.1, 1962.7.19.1	Red Sea
MC	47000	Qatar
ONHM	439, 523, 524, 525, 526, 683, 684, 1015, 1016, 1017, 1020, 1022, 1045, 1047, 1049, 1050, 1222, 1483, 1516, 1557, 1558, 1559, 1560, 1564, 1571, 1572, 1662, 1679, 1911, 1918, 1972, 1973, 2482, 2631, 2632, 2633, 2635, 2677, 2864, 2866, 2867, 2868, 2869, 2889, 2958, 2959, 2975, 2980, 2983, 2985, 2986, 2987, 2988, 2989, 2990, 2916, 3040, 3041, 3051, 3054, 3058, 3062, 3064, 3077, 3080, 3083, 3099, 3100, 3101	Oman
ZMA	20.721, 20.725, 20.726, 20.727, 20.728, 20.736, 20.737, 20.738, 20.899, 21.431, 21.437, 21.450, 21.451	Oman
KVW	3035	Oman

BM British Museum (Natural History), London  
 MC Museum of Comparative Zoology, Cambridge, Mass. USA  
 ONHM Oman Natural History Museum, Muscat  
 KVW Peruvian Centre for Cetacean Research, Lima  
 ZMA Zoological Museum, Amsterdam

## REFERENCES

- Al Robbae, K. 1970. First record of the speckled dolphin, *Sotalia lentiginosa* Gray, 1866, in the Arabian Gulf. *Saugetierk Mitt.* 28: 227-228.
- Al Robbae, K. 1974. *Tursiops aduncus*, bottlenose dolphin: A new record for the Arab Gulf, with notes on Cetacea of the region. *Bull. Basrah. Nat. Hist. Mus.* pp. 7-16.
- Alling, A. 1983. A preliminary report of marine mammal fisheries in Djibouti, Oman and Sri Lanka. Paper NARA/SMMIO/SP32 presented to the Symposium on Marine Mammals of the Indian Ocean, Colombo, Sri Lanka (unpublished). 4pp.
- Alling, A. 1986. Records of odontocetes in the northern Indian Ocean (1981-1982) and off the coast of Sri Lanka (1982-1984). *J. Bombay Nat. Hist. Soc.* 83: 376-394.
- Alling, A., Gordon, J., Rotten, N. and Whithead, H. 1982. WWF-Netherlands Indian Ocean sperm whale study, 1981-1982 interim report. Paper SC/34/Sp9 presented to the IWC Scientific Committee, June 1982 (unpublished) 46pp.
- Baldwin, R.M. 1996. Marine Mammals of the United Arab Emirates. In: *Natural Emirates*, Trident Press, London. pp. 199-212.
- Baldwin, R.M. 1995. *Whales and Dolphins of the United Arab Emirates*. Emirates Printing Press, P.O. Box 5106, Dubai, UAE. p111. [Also in Arabic]. 111pp.
- Baldwin, R.M. 1997. Records of Wildlife and Observed Operational Impacts on Wildlife. Seismic Survey, Block 22, Oman. Environmental Observation Report 1. Unpublished report for Triton Oman Inc., Oman. pp. 1-76
- Baldwin, R.M., Gallagher, M.D. and Van Waerebeek, K. 1999. A review of cetaceans from waters off the Arabian Peninsula. In: *Oman's Natural History*, eds. Fisher, M., Spalton, A. and Gazanfar, S., Backhuys Publishers, Leiden. Pp. 161-189.
- Baldwin, R.M. and Salm, R.V. 1994. *Whales and Dolphins along the Coast of Oman*. Muscat Printing Press, Muscat, Sultanate of Oman. 65pp.
- Basson, P.W., Burchard, J.E., Hardy, J.T. and A.R.G. Price. 1977. *Biotopes of the Western Arabian Gulf*. Aramco, Dhahran. 284pp.
- Beadon, J.J. 1991. A Note on Cetaceans Seen and Live-captured in the Gulf of Aqaba and the Gulf of Suez, 15 September 1980 through 1 September 1981. *UNEP, Mar. Mammal. Tech. Rep.* 3: 111-114.
- de Silva, P. H. D. H. 1987. Cetaceans (whales, dolphins and porpoises) recorded off Sri Lanka, India and from the Arabian Sea and Gulf, Gulf of Aden and the Red Sea. *J. Bombay Nat. Hist. Soc.* 84: 505-525.
- Frazier, J.G., Bertram, G.C. and Evans, P.G.H. 1987. Turtles and Marine Mammals. In: Edwards, A.J. and S.M. Head (eds.) *Red Sea*. Pergamon Press, Oxford. pp. 288-314.
- Gallagher, M. D. 1991. Collections of skulls of Cetacea: Odontoceti from Bahrain, United Arab Emirates and Oman, 1969-1990. *UNEP, Mar. Mammal. Tech. Rep.* 3: 89-97.
- Gray, J. E. 1866. A catalogue of seals and whales in the British Museum, 2<sup>nd</sup> edition. British Museum, London. Pp. 402.
- Harwood, J. 1981. Observation of Cetaceans in the Arabian Sea, November – December 1980. Doc. 7 presented to the Workshop to Plan a Programme of Scientific Research on Cetaceans in the Indian Ocean Sanctuary, Zeist, Netherlands, 1981 (unpublished). 7pp.
- Hershkovitz, P. (1966). Catalog of living whales. Smithsonian Institution, Washington. 259pp
- IUCN/MEPA. 1984. *Report on the distribution of natural habitats and species in the Somali Red Sea*. Saudi Arabia Marine Conservation Programme, Report No. 4.
- IUCN/MEPA. 1985. *Distribution of natural habitats and species along the southern Red Sea coast of Saudi Arabia*. Saudi Arabia Marine Conservation Programme, Report No.11.
- Jefferson, T.A. and Karczmarski, L. 2001. *Sousa chinensis*. *Mammalian Species* 655 : 1-9.
- Leatherwood, S. 1986. Whales, dolphins and porpoises of the Indian Ocean Sanctuary: a catalogue of available information. *Hubbs Marine Research Centre Technical Report* 87-197. 206 pp.
- Leatherwood, S. and R.R. Reeves. 1983. *The Sierra Club Handbook of Whales and Dolphins*. Sierra Club Books, San Francisco. 302 pp.
- Morzer-Bruyns, W.F.J. 1960. The ridgebacked dolphin of the Indian Ocean. *Malay. Nat. J.* 14: 159-165.
- Oman Whale and Dolphin Research Group. 2002. Saif Saree'a II Joint forces military operations Sultanate of Oman Marine Life Surveys and Environmental Monitoring. Pp. 41. (unpublished report).
- Oman Whale and Dolphin Research Group. 2002. A rapid assessment of the causes and extent of a mass stranding of green turtles in the Sultanate of Oman. Final report prepared for MCS. (unpublished report).
- Papastavrou, V. and R. V. Salm. 1991. A note on the recent sightings of cetaceans in Oman: Ra's Suwadi to Rakhut. *UNEP, Mar. Mammal. Tech. Rep.* 3: 211-218.
- Perrin, W.F. 1975. Variation of spotted and spinner porpoise (Genus *Stenella*) in the eastern tropical Pacific and Hawaii. *Bull. Scripps Institution of Oceanography* 21, University of California Press. 206pp

- Perrin, W.F. and Reilly, S.B. 1984. Reproductive parameters of dolphins and small whales of the family Delphinidae. *Rep.Int. Whal. Commn.* (special issue 6): 97-133.
- Pilleri, G. 1973. *Cetologische Expedition Zum Indus Perzischen Golf Und Forschungsreise Nach Goa Und Thailand Im Jahre 1973*. Verlag Hirnanatomisches Institut. Waldau-Bern. 52pp. +27pls [In German].
- Pilleri, G. and M. Gühr. 1974. Contribution to the knowledge of the cetaceans of Southwest and Monsoon Asia (Persian Gulf, Indus Delta, Malabar, Andaman Sea and Gulf of Siam). In: Pilleri (ed.). *Invest. on Cetacea V*: 95-150.
- Preen, A. 1987. Dugongs, dolphins and porpoises. In: *Mammals of the southern Gulf*. Cross, C. (ed.): 74-77. Dubai, Motivate Publishing.
- Preen, A. 1989. Dugongs. Vol 1. The status and conservation of Dugongs in the Arabian Region. MEPA Coastal and Marine Management Series, report No. 10. MEPA, Jeddah, 200pp.
- Raga, J.A., Casinos, A., Filella, S., Raduan, A. 1982. Notes on cetaceans of the Iberian coasts. V. *Crassicauda grampicola* Johnston & Mawson, 1941, (Nematoda) cause of injuries in the pterygoids of some specimens of *Grampus griseus*. *Sauget. Mitt.* 30(4): 315-18.
- Rice, D.W. 1998. *Marine Mammals of the World. Systematics and Distribution*. Special Publication 4, The Society for Marine Mammalogy. 231pp.
- Robineau, D. 1983. Note sur le *Stenella longirostris* (Cetacea, Delphinidae) du golfe d'Aden. *Mammalia* 47(2). pp 237-245.
- Robineau, D. and P. Fiquet. 1992. Initial Data on the Marine Mammals (Sirenia, Cetacea) of the Wildlife Sanctuary for the Gulf Region. *Establishment of a Marine Habitat and Wildlife Sanctuary for the Gulf Region (Phase I)*. Jubail and Frankfurt, CEC/NCWCD. pp208-218.
- Robineau, D. and P. Fiquet. 1994a. Cetaceans of Dawhat ad-Dafi and Dawhat al-Musallamiyah (Saudi Arabia) one year after the Gulf War oil spill. *Courier Forschungsinstitut Senckenberg*. 166: 76-80.
- Robineau, D. and P. Fiquet. 1994b. Cetaceans of the Gulf Sanctuary and adjacent waters. In: *Establishment of a Marine Habitat and Wildlife Sanctuary for the Gulf Region. Final Report for Phase II*. Jubail and Frankfurt, CEC/NCWCD. pp. 501-513.
- Robineau, D. and P. Fiquet. 1996. The Cetacea of the Jubail Marine Wildlife Sanctuary, Saudi Arabia. In: *A Marine Wildlife Sanctuary for the Arabian Gulf. Environmental Research and Conservation Following the 1991 Gulf War Oil Spill*. NCWCD, Riyadh and Senckenberg Institute, Frankfurt a.M. pp 438-458.
- Robineau, D. and Rose, J.M. 1984. Les cétacés de Djibouti. Bilan des connaissances actuelles sur la faune cétologique de la mer Rouge et du golfe d'Aden. *Bull. Mus. Natn. Hist. Nat., Paris* (4)6(1): 219-49.
- ROPME. 1986. *Report of the first meeting of experts on mortality of marine mammals*. Kuwait. November 22-23, 1980. ROPME 1-29.
- Ross, G. J.B., Heinsohn, G.E. and V.G. Cockcroft. 1994. Humpback Dolphins – *Sousa chinensis* (Osbeck, 1765), *Sousa plumbea* (G. Cuvier, 1829) and *Sousa teuszii* (Kukenthal, 1892). pp. 23-42. In: S.H. Ridgway and R. Harrison (eds.). *Handbook of Marine Mammals* 5, 416p.
- Ross, J. P. 1981. Recent marine mammal sightings in the Sultanate of Oman (1980/1981). Document 23 presented at Workshop to Plan a Programme of Scientific Research on Cetaceans in the Indian Ocean Sanctuary, Zeist, Netherlands, 28 September - 1 October. (unpublished).
- Salm, R.V. 1991. Live and Beached Cetacean Observations, Sultanate of Oman. Scientific Results of the IUCN Coastal Zone Management Project. CZMP4:F14. Report prepared for the Ministry of Commerce and Industry, Sultanate of Oman. 26 pp. (unpublished).
- Salm, R.V. 1992. Impact of Fisheries on Environment and Wildlife, Sultanate of Oman. Scientific Results of the IUCN Coastal Zone Management Project. CZMP4:F17. Report prepared for the Ministry of Commerce and Industry, Sultanate of Oman. 19 pp. (unpublished).
- Salm, R.V., Jensen, R.A.C. and Papastavrou, V.A. 1993. *Marine Fauna of Oman: Cetaceans, Turtles, Seabirds and Shallow Water Corals*. IUCN, Gland, Switzerland. 66 pp.
- Scheleyer, M.H. and R.M. Baldwin. 1999. Biodiversity Assessment of the Northern Somali Coast East of Berbera. IUCN East Africa Programme, Somali Natural Resources Management Programme. IUCN, Gland, Switzerland. Pp. 42.
- Sheppard, C., Price, A. and Roberts, C. 1992. *Marine Ecology of the Arabian Region. Patterns and Processes in Extreme Tropical Environments*. Academic Press Ltd., London. 359pp.
- Small, J.A. and G. Small. 1991. Cetacean Observations from the Somali Democratic Republic, September 1985 through May 1987. *UNEP, Mar. Mammal. Tech. Rep.* 3:179-210.
- Van Waerebeek, K. 1993. Geographic variation and sexual dimorphism in the skull of the dusky dolphin, *Lagenorhynchus obscurus* (Gray, 1828). *Fishery Bulletin* 91: 754-774.
- Weidleplan. 1992. *Study for Wildlife and Conservation Areas - Master Plan for the Coastal Areas of the Barr al Hikman and Masirah Island*. Weidleplan, Muscat, Sultanate of Oman. Unpublished report for the Government of Oman.



**APPENDIX I. Cranial measurements and tooth counts used for descriptive craniometrics of *Sousa* from Oman (slightly modified from Perrin, 1975).**

1. condylobasal length (CBL)
2. rostrum length (RL)
3. rostrum width at base (RWB)
4. rostrum width at 60mm (RW60)
5. rostrum width at  $\frac{1}{4}$  length (RW14L)
6. rostrum width at  $\frac{1}{2}$  length (RW12L)
7. rostrum width at  $\frac{3}{4}$  length (RW34L)
8. premaxillary width at  $\frac{1}{2}$  length (PRMX12L)
9. tip of rostrum to right external nare (TREXTN)
10. tip of rostrum to internal nares (TRINTNS)
11. preorbital width (PRORBWI)
12. postorbital width (POSTORW)
13. zygomatic width (ZYGW)
14. parietal width (PARWI)
15. greatest width of premaxillaries (GWPRMX)
16. external nares width (EXTNSW)
17. internal nares width (INTNSW)
18. temporal fossa length (TEMFOSL)
19. temporal fossa width (TEMFOW)
20. orbital length (ORL)
21. antorbital length (ANTPRL)
22. length upper tooth row (LUTR)
23. length lower tooth row (LLTR)
24. ramus length (RAL)
25. ramus height (RAH)
26. number alveoli upper left (UL)
27. number alveoli upper right (UR)
28. number alveoli lower left (LL)
29. number alveoli lower right (LR)
30. tooth width transverse (TW)
31. bulla length (BUL)
32. bulla width (BUW)
33. periotic length (PERL)
34. height braincase (HBR)
35. length braincase (LBR)
36. maximum width palatine (MXWPAL)
37. maximum span occipital condyles (MXSOCC)
38. maximum width nasals (MAXWNAS)

**APPENDIX II. Cranial morphometrics (in mm) and tooth counts of cranially adult Indian Ocean humpback dolphins (n=18) from Oman.**

	<b>N</b>	<b>Minimum</b>	<b>Maximum</b>	<b>Mean</b>	<b>Std. Deviation</b>
<b>CBL</b>	13	502.0	562.0	521.615	16.546
<b>RL</b>	14	301.0	347.0	317.821	13.129
<b>RWB</b>	16	107.00	121.00	113.3437	3.7493
<b>RW60</b>	15	72.00	83.00	78.1333	3.0965
<b>RW14L</b>	14	66.50	76.50	72.2857	2.5997
<b>RW12L</b>	14	41.50	49.00	45.9643	2.0982
<b>RW34L</b>	13	29.00	34.50	31.5769	1.8467
<b>PRMX12L</b>	14	24.50	34.00	28.3929	2.3220
<b>TREXTNS</b>	13	337.00	384.00	357.7692	13.4855
<b>TRINTNS</b>	11	351.50	392.00	363.6818	13.1154
<b>PRORBWI</b>	15	175.00	201.00	182.3667	7.1651
<b>POSTORW</b>	16	202.00	229.00	208.9375	7.1621
<b>ZYGW</b>	16	198.00	226.00	206.5625	7.8270
<b>PARWI</b>	16	150.50	170.00	159.2813	5.1768
<b>GWPRMX</b>	16	79.50	87.50	82.9688	2.3977
<b>EXTNSW</b>	17	52.50	62.00	56.2059	2.6871
<b>INTNSW</b>	14	58.00	64.00	61.1786	1.7498
<b>TEMFOSL</b>	16	100.00	122.00	107.0625	5.7500
<b>TEMFOW</b>	16	78.50	93.00	84.8750	3.8622
<b>ORL</b>	16	53.5	60.5	57.313	1.905
<b>ANTPRL</b>	15	37.5	47.5	43.733	2.871
<b>LUTR</b>	14	263.0	310.0	279.500	12.468
<b>LLTR</b>	5	235.0	272.0	260.800	15.023
<b>RAL</b>	5	436.0	446.0	440.200	4.494
<b>RAH</b>	5	81.5	88.0	85.200	2.660
<b>UL</b>	10	33.0	37.0	34.700	1.418
<b>UR</b>	11	33.0	36.0	34.182	1.168
<b>LL</b>	3	31.0	34.0	32.667	1.528
<b>LR</b>	5	31.0	34.0	32.800	1.095
<b>TW</b>	6	5.6	6.1	5.800	.210

<b>BUL</b>	1	36.0	36.0	36.000	.
<b>BUW</b>	1	19.9	19.9	19.900	.
<b>PERL</b>	1	32.5	32.5	32.500	.
<b>HBR</b>	16	129.0	148.0	133.500	4.861
<b>LBR</b>	16	140.5	167.0	150.938	5.651
<b>MXWPAL</b>	16	44.5	52.5	48.219	2.316
<b>MXSOCC</b>	16	91.0	115.0	103.781	6.565
<b>MAXWNAS</b>	14	48.5	58.0	52.964	2.735

**APPENDIX III. Cranial morphometrics expressed as percentage of condylobasal length for Indian Ocean humpback dolphins from Oman. Sample includes cranially adult and subadult specimens.**

	N	Minimum	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
<b>RL%</b>	20	59.4	62.2	60.872	.203	.907
<b>RWB%</b>	20	20.70	22.82	21.8903	.1327	.5935
<b>RW60%</b>	19	14.37	15.98	15.1841	.1033	.4502
<b>RW14L%</b>	19	13.23	15.14	14.0967	.1294	.5641
<b>RW12L%</b>	19	8.27	9.70	9.0494	.1082	.4717
<b>RW34L%</b>	16	5.48	6.89	6.1393	9.697E-02	.3879
<b>PRMX12L%</b>	19	4.63	6.31	5.5419	9.051E-02	.3945
<b>TREXTNS%</b>	20	66.47	69.43	68.3093	.2045	.9144
<b>TRINTNS%</b>	16	67.42	70.75	69.3226	.2690	1.0760
<b>PRORBWI%</b>	19	34.06	36.55	35.2663	.1698	.7402
<b>POSTORW%</b>	19	39.32	42.12	40.4749	.1753	.7641
<b>ZYGW%</b>	20	38.77	41.65	40.0384	.1957	.8754
<b>PARWI%</b>	20	28.40	34.59	31.2207	.3347	1.4967
<b>GWPRMX</b>	19	15.19	17.01	16.0333	.1052	.4586
<b>EXTNSW%</b>	19	10.00	11.83	10.9427	.1040	.4535
<b>INTNSW%</b>	18	11.01	13.01	11.8150	.1142	.4846
<b>TEMFOSL%</b>	20	19.15	21.71	20.5142	.1715	.7671
<b>TEMFOW%</b>	20	15.57	17.62	16.3964	.1387	.6205
<b>ORL%</b>	20	10.1	12.1	11.085	.106	.475
<b>ANTPRL%</b>	20	7.4	9.1	8.423	.100	.448
<b>LUTR%</b>	18	50.6	55.2	53.274	.282	1.197
<b>LLTR%</b>	5	44.3	53.3	50.688	1.622	3.626
<b>RAL%</b>	4	85.5	86.4	85.821	.192	.384
<b>RAH%</b>	4	16.0	17.4	16.578	.284	.569
<b>HBR%</b>	20	24.4	28.0	25.992	.221	.987
<b>LBR%</b>	20	27.7	31.1	29.260	.199	.889
<b>MXWPAL%</b>	19	8.4	10.2	9.346	.119	.518
<b>MXSOCC%</b>	20	17.5	23.0	20.010	.317	1.416
<b>MAXWNAS%</b>	14	8.9	11.4	10.207	.173	.646



